quantity of water in the bottom of the jar it was noticed that the electrification did not commence to be perceptible generally till about the end of the first minute; and that it went on augmenting perceptibly for a minute or more after the bubbling was stopped. The following experiment was therefore tried several times. One of us stood leaning over the jar, with the head about 10 ins. above it, and the mouth so partly closed that breathing was effected sideways; another blew the bellows; and another took the readings of the electrometer. After bubbling had been going on for some minutes, and the readings were rising gradually (4 volts per 10 minutes, as in § 18), blowing was stopped. As soon as the bubbling ceased, the first-mentioned observer, without moving his head or his body (see § 7, regarding the necessity to have the electrometer screened from outside influences) blew into the jar to displace the negatively electrified air in it. In every case the electrometer reading showed instantly a small rise in the positive direction.

In the carrying out of these experiments we have received much valuable help from Walter Stewart, M.A., and Patrick Hamilton, B.Sc.

§ 33. The very interesting experiments described by Lenard, in his paper on the Electricity of Waterfalls,* and by Professor J. J. Thomson, on the Electricity of Drops,† show phenomena depending, no doubt, on the properties of matter to which we must look for explanation of the electrical effects of bubbling described in our present communication, and of the electrification of air by drops of water falling through it, to which we have referred as having been found in previous experiments which were commenced in 1890 for the investigation of the passage of electrified air through tubes.‡

II. "Note on the Spectrum of Argon." By H. F. Newall. Communicated by Lord Rayleigh. Received February 14, 1895.

In the course of a spectroscopic investigation in which I have been for some time past engaged, a line spectrum, which so far as I was able to make out was unknown, has frequently presented itself upon my photographs. It appeared in May and June, 1894, under conditions which led me to call it, for the sake of convenience, "the low-pressure spectrum." After their announcement at the Oxford meeting of the British Association, it seemed for many reasons

* 'Wiedemann's Annalen,' 1892, vol. 46, pp. 584—636.

† 'Phil. Mag.,' April, 1894, vol. 37, pp. 341—358.

‡ "Electrification of Air by a Water Jet." By Magnus Maclean and Makita Goto, 'Phil. Mag.,' August, 1890, vol. 30, pp. 148—152.

natural to borrow the first letter of Lord Rayleigh's and Professor Ramsay's names to give to the unknown lines, and in the measurements of the photographs which showed the lines well, there appears an "R" against seventeen lines out of sixty-one measured, the remaining lines being known to belong to Hg, H, N, and nitrocarbons. It transpires now, as I learnt from reading the abstract of the paper in which Lord Rayleigh and Professor Ramsay describe their consummate researches on argon, that the symbol "A" should have been used instead of "R" to designate the lines on my photographs. For the lines are Argon lines.

The conditions under which the spectrum of argon has appeared in my investigations are of interest at the present time, and I hope a description of them may not be unacceptable.

A glass bulb was sealed hermetically to a mercury pump of the Hagen-Töpler form, in which there was strong sulphuric acid floating on the surface of the mercury. The bulb was exhausted as low as possible and refilled with air. The pressure was reduced to about 180 **M**illionths of an atmosphere (= 0·14 mm.), at which pressure a bright discharge could be passed through the residual gases by means of Professor J. J. Thomson's method of surrounding the bulb by a coil of wire, which carries a very rapidly alternating current produced by the discharge of a condenser.

The discharge was passed for thirty minutes, during which time a photograph of the spectrum was taken. The pressure of the gas in the bulb fell during the passage of the discharge from the value 174 **M** (= 0·13 mm.) to 112 **M** (= 0·085 mm.). The spectrum shows the bands of nitrogen strong, also mercury lines and nitrocarbon groups strong, hydrogen weak, no oxygen or argon.

Again the discharge was passed for thirty minutes and a new photograph was taken. The pressure fell from 100 M (= 0·076 mm.) to 20 M (= 0·015 mm.); the nitrogen spectrum had faded considerably, and there had appeared a number of fine lines which I was unable, in spite of careful efforts, to identify with the lines of any known substances.

The nature of my method of investigation of spectra is such that it is not difficult to pick out of the numerous spectra which appear superposed on the photographic plate, the lines which belong to any one spectrum. [The photographic reproductions sent herewith show clearly the ease with which this may be done.]

The results of measurement made in the last few days of seventy-two lines in my "low-pressure spectrum" are given below, and side by side are given the measurements of the wave-lengths determined by Mr. Crookes for the argon lines.

The agreement of the measurements shows conclusively that we have been measuring the same spectrum. Between H_γ and wave-

length 370, the agreement is all that we could hope for, taking into account the fact that my measurements were not made with a view of giving a final and carefully-considered set of measurements of wave-lengths, but between H_γ and H_β there is a systematic difference of about 3 tenth-metres, which I am unable at present to account for. The agreement of grouping and intensity, however, leaves no doubt as to the identity of the spectrum of my low-pressure lines with the spectrum of argon. I have reduced my measurements with reference to Rowland's scale of wave-lengths, and I infer from the value adopted for the H_β (F) line, that Ångström's scale has been used in Mr. Crookes' reduction. The difference between the scales is not enough to account for the discrepancies above referred to.

The experiments were repeated, with slight variations, several times with results which, so far as the spectrum of argon is concerned, were constant. But it was noted that continued passage of the discharge appears to result in the attaining of a certain minimum pressure, after which there is slight and slow rise to a tolerably-fixed pressure. It is not necessary to dwell on these points in the present note.

It is interesting to find argon asserting itself, unsolicited, in quite new circumstances, and under conditions which practically constitute one more mode of separating argon from nitrogen—namely, the getting rid of nitrogen by passing electric discharge through it in the presence of hydrogen or moisture and acid.

Table of Wave-lengths.

H. F. Newall.		William Crookes. January 24, 1895. The Two Spectra of Argon.			
Measurements of lines on photograph.		Blue.		Red.	
Wave-length.	Intensity.	Wave-length.	Intensity.	Wave-length.	Intensity.
4879·8	5	487·9	10	487·9	4
4847·2	5	484·75	1		
4808·0	9	480·50	7		
4766·6	5	476·30	1		
4738·0	8	473·45	6		
4729·4	6	472·66	2		
				470·12	8
4659·6	7	465·65	5		
4644·0	1				
4639·0	2				
4632·1	4			462·95	5

Table of Wave-lengths—*continued.*

H. F. Newall.		William Crookes. January 24, 1895. The Two Spectra of Argon.			
Measurements of lines on photograph.		Blue.		Red.	
Wave-length.	Intensity.	Wave-length.	Intensity.	Wave-length.	Intensity.
4611·0	9	460·80	8		
4592·0	8			459·45	2
		458·69	6		
4581·2	6	457·95	6		
4546·5	7	454·35	7		
				451·40	2
		450·95	8	450·95	9
4482·2	6	447·83	6		
4460·0	2				
4431·3	10	442·65	10		
4426·0	10	442·25	10		
4421·2	4				
4414·1	4				
4401·7	9	439·95	10		
4400·1	5				
4379·8	8	437·65	9		
4375·8	3				
4370·4	8	436·90	9		
4351·4	7	434·85	10		
4336·0	2			434·50	5
4330·8	10	433·35	9	433·35	9
4308·7	4			430·05	9
4299·4	4	429·90	9		
4282·1	6				
4277·4	8 ? N	427·70	3		
		427·20	7	427·20	8
4266·4	9 ? N	426·60	6	426·60	4
		425·95	8	425·95	9
		425·15	2	425·15	3
4227·5	8	422·85	6		
		420·10	10	420·10	10
CN group has, though only of intensity 5, obliterated this set of lines.		419·80	9	419·80	9
		419·15	9	419·15	9
		418·30	8	418·30	8
		416·45	8	416·45	4
		415·95	10	415·95	10
				415·65	6
4155·8					
4130·9	6	413·15	3		
4104·2	8	410·50	8		
4082·2	4				
4075·8	3				
4072·4	9	407·25	8		
4069·7	2				
4042·7	5	404·40	8	404·40	9
4038·2	5				

Table of Wave-lengths—*continued.*

H. F. Newall.		William Crookes. January 24, 1895. The Two Spectra of Argon.			
Measurements of lines on photograph.		Blue.		Red.	
Wave-length.	Intensity.	Wave-length.	Intensity.	Wave-length.	Intensity.
4035·0	2				
4033·7	3	403·30	1		
4013·8	8	401·30	8		
3994·8	6				
3991·3	4				
3979·2	3	397·85	1		
3973·0	4				
3968·0	7	396·78	3		
		394·85	9	394·85	10
3944·1	5	394·35	3		
3932·3	5				
3930·8	3	393·18	3		
3928·2	8	392·85	9		
3920·3	6				
		392·75	3		
3918·8	5				
		391·50	1		
3892·2?	—			390·45	8
3883·2	5	389·20	5		
3873·4	4	387·55	2		
		387·18	2		
3868·1	6	386·85	8		
3850·8	7	385·15	10		
		384·55	1		
		383·55	2	383·55	3
3827·0	—	382·75	2		
3809·8	4	380·95	4		
		380·35	1		
		379·95	1		
3781·8	6	378·08	9	377·15	1
		377·05	2		
3766·1	5	376·60	8		
3750·2	3				
3738·8	3	373·85	3		
3730·0	8	372·98	10		
3719·2	2	371·80	4		